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MULTIWAVELENGTH IR LASER DEVICE.(U)
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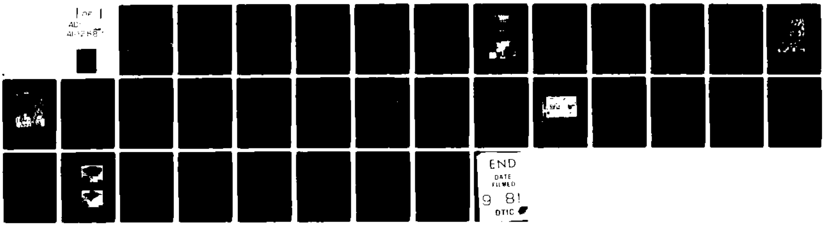

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FINAL TECHNICAL REPORT
FOR
MULTIWAVELENGTH IR LASER DEVICE

ER80-4255

17 OCTOBER 1980

PREPARED FOR

DEPARTMENT OF THE ARMY
DRDEL-AQ-M-2(KIN)
USAERADCOM
FORT MONMOUTH, NEW JERSEY 07703

CONTRACT NO. DAAB07-78-C-2429

PREPARED BY

RAYTHEON COMPANY
EQUIPMENT DEVELOPMENT LABORATORIES
ELECTRO-OPTICS SYSTEMS LABORATORY
SUDBURY, MASSACHUSETTS 01776

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SECTION 1

INTRODUCTION

The primary intent of the Multiwavelength IR Laser Device program was to design a CO_2 TEA laser rangefinder system, based on building blocks originating in the HSTV(L) effort. The system was to be modularized to the maximum extent possible, and so configured as to permit maximum operational flexibility, i.e., the transmitter module could be used alone, as a designator, with or without its output collimator; the receiver could be remotely located as a passive receiver, etc. Additionally, AN/GVS-5 video/counter elements, supplied as GFE, were to be incorporated as a part of the overall rangefinder system.

Within the major subsystems, i.e., Transmitter and Receiver, modularity of discrete components was desired, and implemented in the following areas:

Transmitter:
- PFN
- Laser Tube
- High Voltage Supplies
- Ballast Network
- Collimating Optics
- Sighting Telescope

Receiver:
- Detector/Dewar
- Cryostat
- Receiver Optics
- Preamp Module
- Counter/Interface Module
- Sighting Telescope

The tripod-mounted system has repeatedly demonstrated boresight retention by actual field replacement of critical modules, such as the laser tube and transmitter optics modules. Conversion of

the HSTV(L)-based ceramic TEA laser module from a flowing gas device to a sealed-off configuration proved to be much more time consuming than had originally been anticipated, but ultimately resulted in a continuous 5 PPS capability with excellent TEM_{00} shot-to-shot repeatability characteristics, but slightly below the 10 mJ/pulse design goal.

Field testing to the maximum capability of our local test site resulted in S/N ratios in excess of 35 dB over a 2700 meter range to targets of opportunity on a nearby hilltop. Multiple target discrimination was also demonstrated by setting the minimum range control to a range slightly greater than the nearest target, and range readings to the farthest target were made.

A comparison of contractual requirements and achieved parameters follows:

TABLE 1-1

SUMMARY OF CONTRACTUAL REQUIREMENTS vs PARAMETERS ACHIEVED

PARAMETER	CONTRACTUAL REQUIREMENTS	ACHIEVED
Output Energy	10 mJ	7 mJ
Beam Divergence	.5 mrad	.5 mrad
Receiver Aperture	5.0 in.	5.0 in.
Receiver FOV	1 mrad	2.6 mrad
Pulse Shape	60 - 80 ns min. tail	80 ns - .5 μs tail
Sealed-off Lifetime	T.B.D.	10^6 shots
Operating Modes	1 - 5 PPS Burst Mode - Flowing	---
	1 - 2 PPS Sealed	1 - 5 PPS Continuous
Range Accuracy	± 10 m	± 10 m
Range Resolution	50 m	50 m
Range - Clear Air	5 km	2.7 km* (35 dB SNR)
Boresight Tolerance	± .4 mrad (Xmit-Rcvr)	± .2 mrad - measured

*limit of local area test range

SECTION 2

TECHNICAL DISCUSSION

The sections to follow are an account of the development and testing program conducted by the Raytheon Company, Equipment Development Laboratories, Sudbury, Mass., on the Multiwavelength IR Laser Device program. Requirements of individual equipments are discussed and the reasons for configurating along certain lines are presented.

2.1 EQUIPMENT CONSIDERATIONS - CONFIGURATION

The modular CO_2 TEA rangefinder (Figure 2-1) consists of three major elements, so configured as to allow maximum operational flexibility, and whose discrete system elements have been modularized to the greatest extent possible within the scope of this program.

The three subsystems which, when combined, make up the total rangefinder system, consist of the transmitter assembly, receiver assembly, and the PRF generator/system control unit, which is incorporated as an integral part of the mounting plate for the two other elements. The mounting plate also contains fixed mounting lugs on its upper surface, designed to interface with keyhole-shaped holes in the baseplates of both receiver and transmitter units, and permit ready removal of either unit and return, without affecting boresight.

The rangefinder was designed as a tripod-mounted system, and requires an external 28 VDC power source and high pressure nitrogen for the receiver unit's cryogenically cooled detector. Figure 2-2 shows the internal arrangement of both plate-mounted units.

2.2 TRANSMITTER ASSEMBLY

The transmitter assembly consists of a ceramic, sealed mini-TEA laser module, PFN and trigger electronics, high voltage power supplies and a pyroelectric detector, from which T_o is derived.

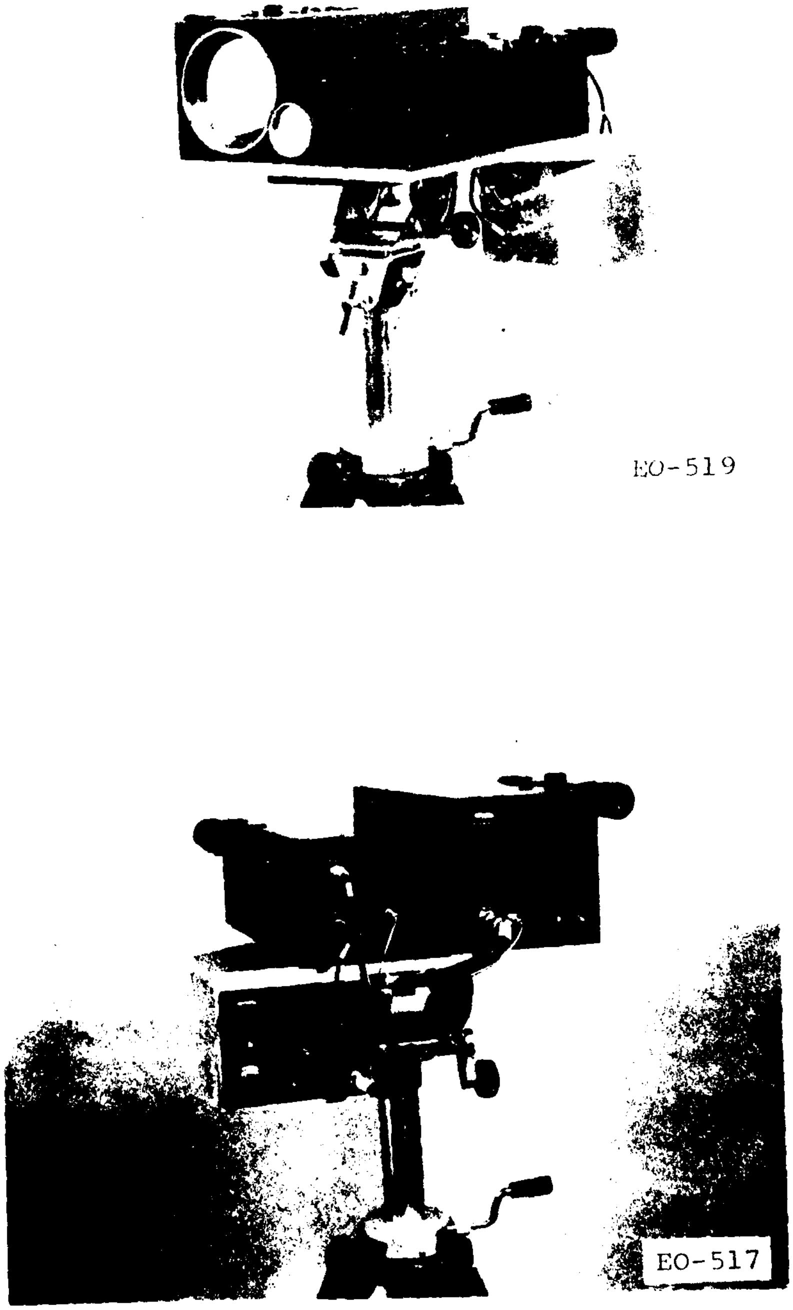


Figure 2-1. Modular Rangefinder

The laser/PFN module is configured in such a way as to define an output optical axis for the transmitter assembly. Both components interface electrically via contact strips and beryllium copper finger stock, and are mechanically indexed in such a way as to permit removal and/or replacement of the laser component in the field without affecting system boresight. The PFN trigger electronics, trigger transformers and spark gap are also contained within the PFN assembly.

The rearmost section of the transmitter enclosure consists of a fully shielded compartment, wherein is contained a fast pyroelectric detector which is aligned with the laser beam axis and generates the start pulse for the rangefinder counting electronics. (The rear laser mirror is a partial reflector to allow low level optical energy to impinge on the pyrodetector, shown in Figure 2-2.) Also included in this compartment are in-line RFI filters on all of the input power and signal leads.

As an aside, it must be noted that the transmitter was originally configured to contain the system's PRF generator in its own shielded compartment, as well as the transmitter control panel. Both were relocated to their present location after extensive tests indicated that EMI induced failures within the PRF circuitry could not adequately be suppressed to acceptable levels.

The transmitter assembly also incorporates a two-element, 12.5X Germanium beam expander of the Galilean type, wherein the laser output is expanded and collimated to ≈50 mm. The beam expander is flange mounted and pin indexed to the front of the transmitter enclosure. Its input element is fully adjustable in x-y-z planes to permit an optimum match with the laser's output characteristics.

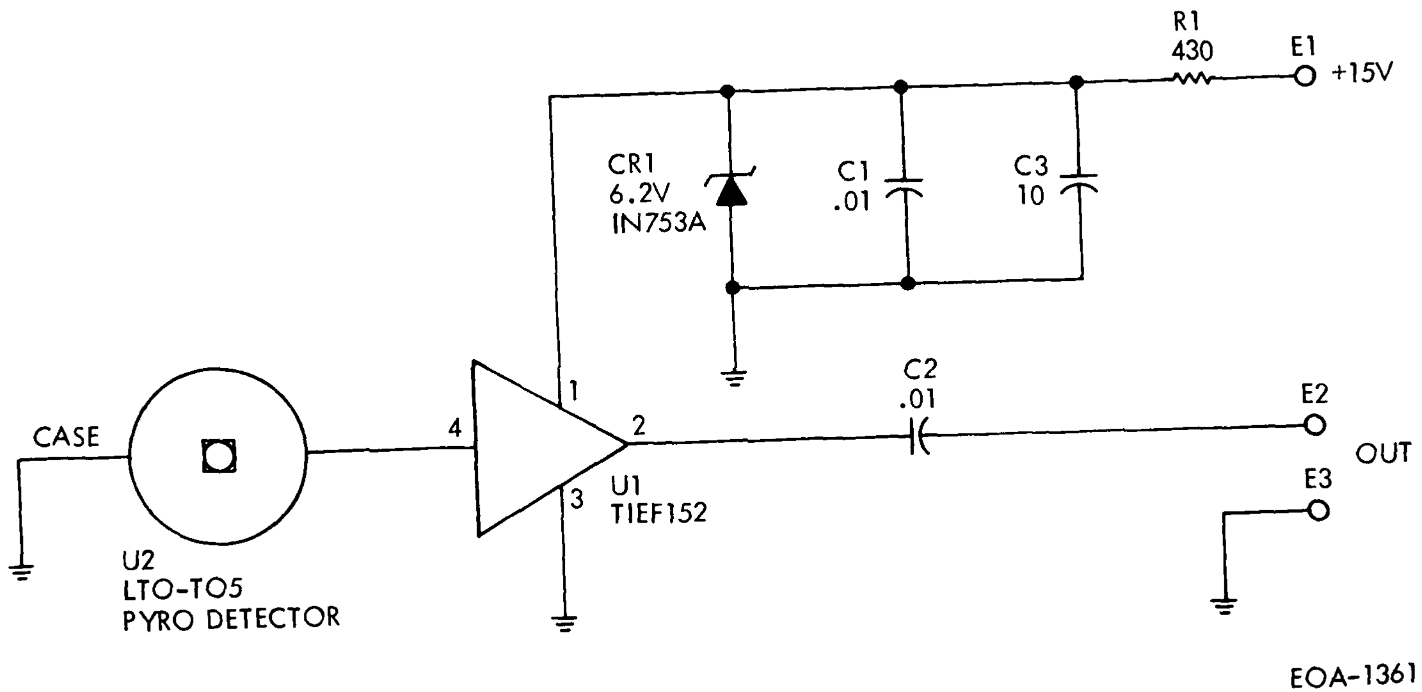


Figure 2-2. Pyroelectric T_o Detector

2.3 CERAMIC LASER TUBE

The ceramic TEA laser has been designed as a field-replaceable module, and has been so configured as to interface with the PFN mainframe electrically via contact strips on either side of the tube block. Indexing slots are incorporated into the base of the laser block, which mate with elements of the PFN mainframe, thus carrying internal optical references out to a principal mechanical reference plane. Field interchangeability of these tubes has been demonstrated under a previous contract, wherein system boresight was totally unaffected with repeated substitution of tubes.

In order to ensure a TEM_{OO} output beam characteristic, an aperture is located within the optical cavity immediately behind the output coupler.

2.4 RECEIVER

The receiver assembly consists primarily of a HgCdTe detector, at the focus of a 5.0" diameter, f/1.5 germanium aspherical lens, having a measured blur circle of 80 microns. The combination of the .5 mm dia. detector element with the 190.5 mm focal length yields an effective receiver FoV of 2.6 mrad, approximately a factor of 5 greater than the beam divergence of the transmitted beam.

Adjacent RFI shielded compartments contain post-detection amplifiers, range-counting circuits (AN/GVS-5) and interface circuitry. The rearmost compartment contains low voltage power supplies, an LED range readout and controls associated with the AN/GVS-5's minimum range circuit. This area also provides access to and high pressure plumbing associated with the detector's Joule-Thomson cryostat.

The post-detection electronics are contained in fully shielded compartments located on either side of the HgCdTe Dewar, and are accessible from either side of the receiver assembly via RFI gasketed access plates. The enclosure on the outboard side of the

receiver contains Raytheon-designed preamplifier and detector bias networks coupled with the RCA AN/GVS-5 video amplifier, threshold detector and CFAR hybrid microcircuit module. The inboard electronic enclosure contains the RCA AN/GVS-5 digital range counter/display hybrid, as well as the conversion circuitry required to convert the RCA output display format to that required to drive the rear panel mounted LED readout devices. Figure 2-3 shows the preamp electronics with access cover removed, and Figure 2-4 shows the range counter/interface compartment.

2.4.1 RCA AN/GVS-5 CIRCUIT IMPLEMENTATION VIDEO CARD AND DIGITAL RANGE CARD

AN/GVS-5 is the nomenclature for a handheld laser rangefinder made by RCA for the U.S. Army. Although it operates at a shorter wavelength than CO_2 lasers, it contains certain circuits that are well suited for use in CO_2 rangefinder applications.

Most of the AN/GVS-5 circuitry that would be useful in a CO_2 rangefinder is contained on two subminiature cards of hybrid design. These two cards are the Video Amplifier and the Digital Range Counter. In order to properly implement these cards, certain modifications and/or additional circuits were necessary.

The first circuit needed was one to provide a start count pulse to the Digital Range card. Since the Digital Range card employs CMOS 12 volt logic, a 12 volt start pulse was generated from the laser when it fired. This is shown on the schematic of Figure 2-5.

T_O is a positive pulse which actuates the high speed comparator AM686HM generating a negative square pulse at its output. This pulse has a width approximately equal to the width of the laser pulse. This negative pulse in turn shuts off the first transistor 2N2369A which was normally on because pin 9 of the AM686HM was high. The output of the transistor thus goes high feeding a 12 V sharp rise time pulse through the second transistor emitter follower to start the count on the RCA Digital Range Counter.

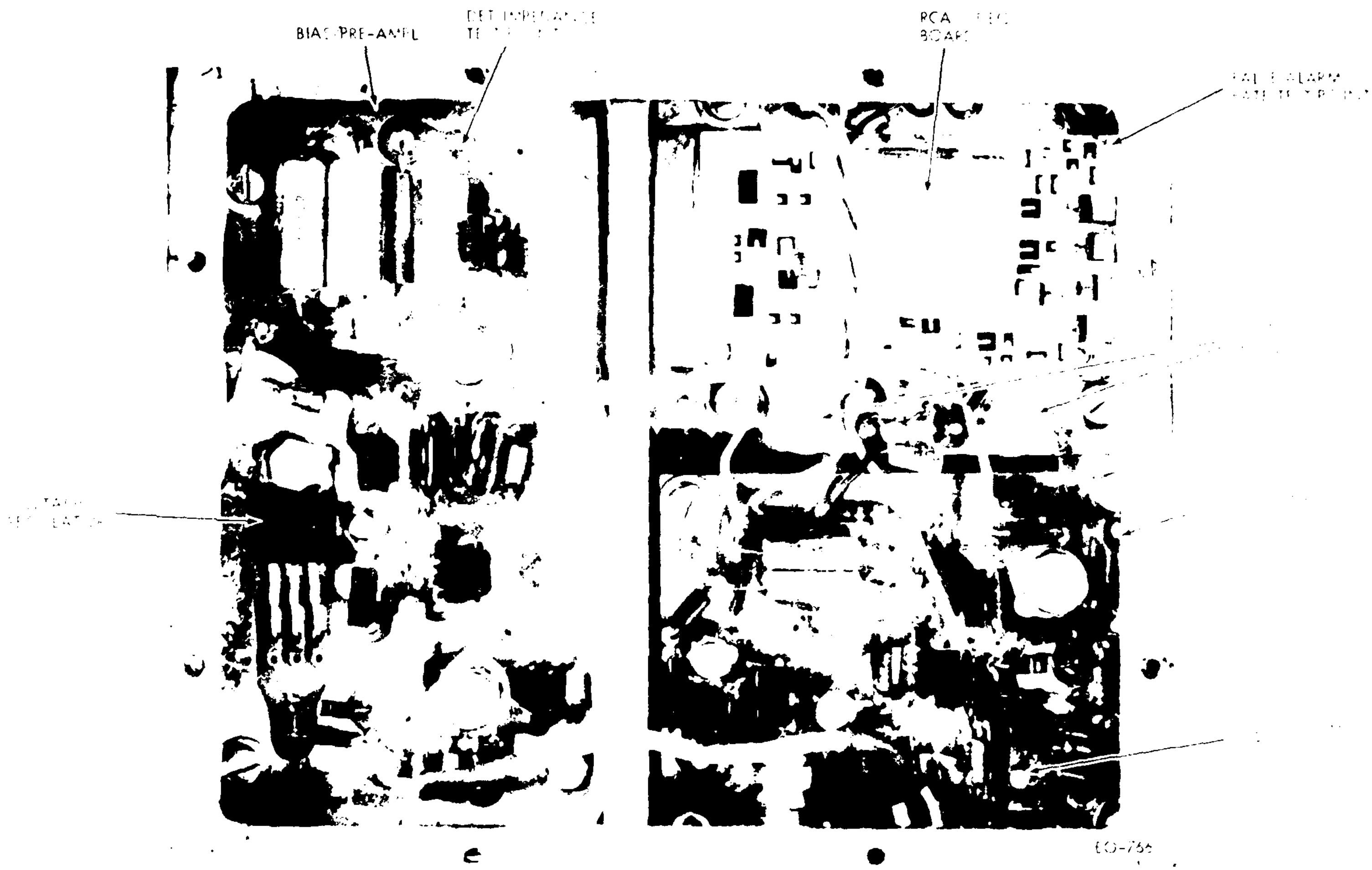


Figure 2-3. Pre-Amplifier Compartment

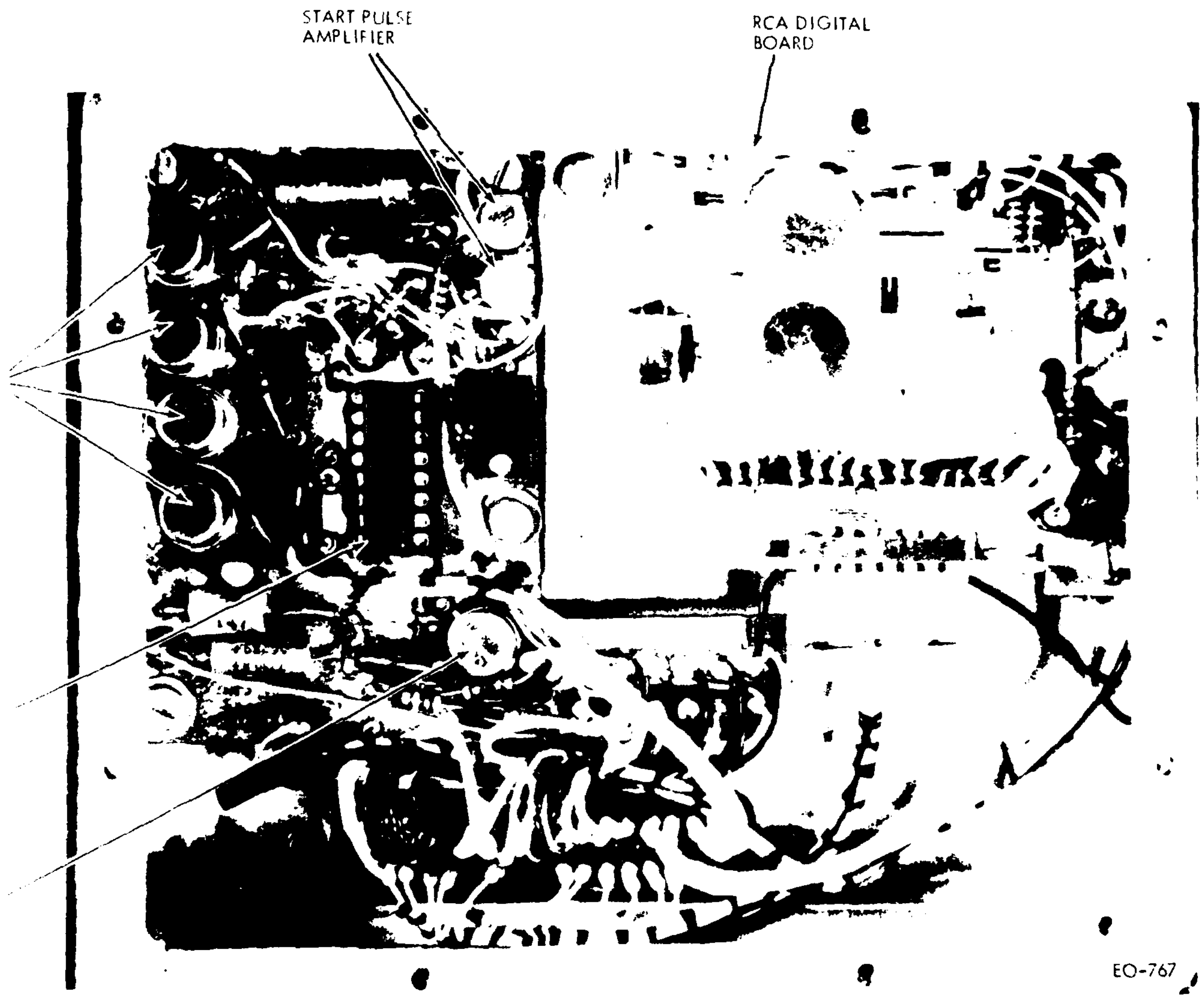


Figure 2-4. Range Counter/Interface Compartment

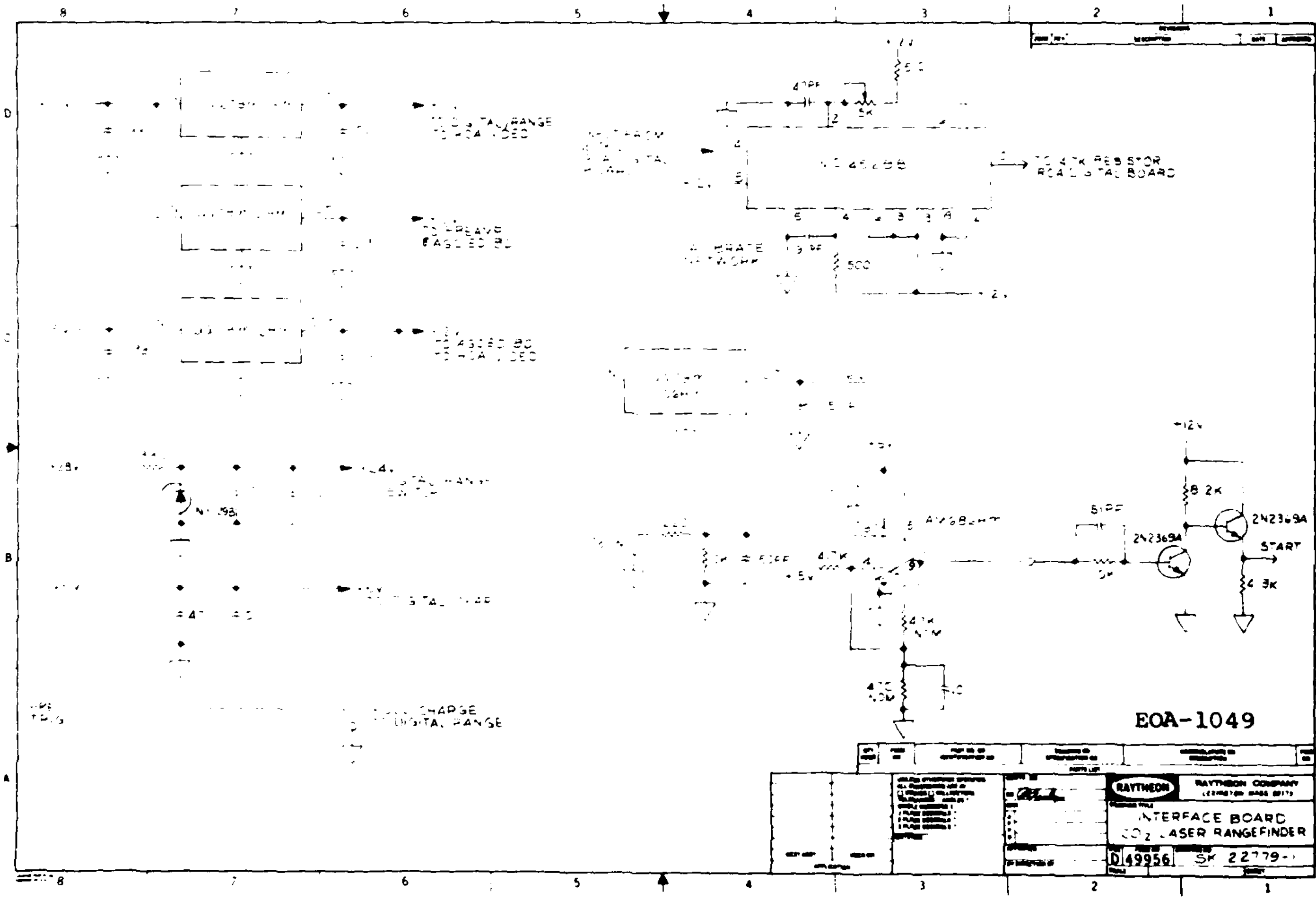


Figure 2-5. Interface Board

A second circuit needed is shown in the upper right hand corner of Figure 2-5. This is a calibration circuit which interrupts the normal stop count pulse coming to the RCA Digital Range Counter from the RCA Video card and provides an adjustable delay. The delay is provided by monostable MV MC14528B which is needed to calibrate range readings for time delays within the system.

A third circuit necessary was the full charge pulse to the Digital Range card. This came from the PRF generator and is a positive +12 V pulse occurring before laser trigger and also prior to the T_o pulse. Its duration is one-half second or less depending on the PRF selected. Without this pulse, the Digital Range card will not function properly.

Other circuits shown on Figure 2-5 were needed to provide proper operating voltages for the RCA Video and Digital Range cards.

Figure 2-6 gives a block diagram of the wiring connections required to implement the two RCA electronic cards in the CO_2 rangefinder. Each of the inputs and outputs on each card is explained below:

RCA VIDEO CARD

Pin 1 - Stop output - sends out an appropriate stop pulse to the RCA Digital Range Card upon receipt of a valid return target pulse.

Pin 2 - TPG input - Logic 1 level prior to transmit - returns to Logic 0 @ time of start pulse. Reduces gain of video amplifier to close-in targets.

Pin 3 - +12 V input - power to video card from interface board (Figure 2-5).

Pin 4 - Ground

Pin 5 - Video input - received signals at the rangefinder detector are preamplified and fed in at this point for further amplification and threshold detection.

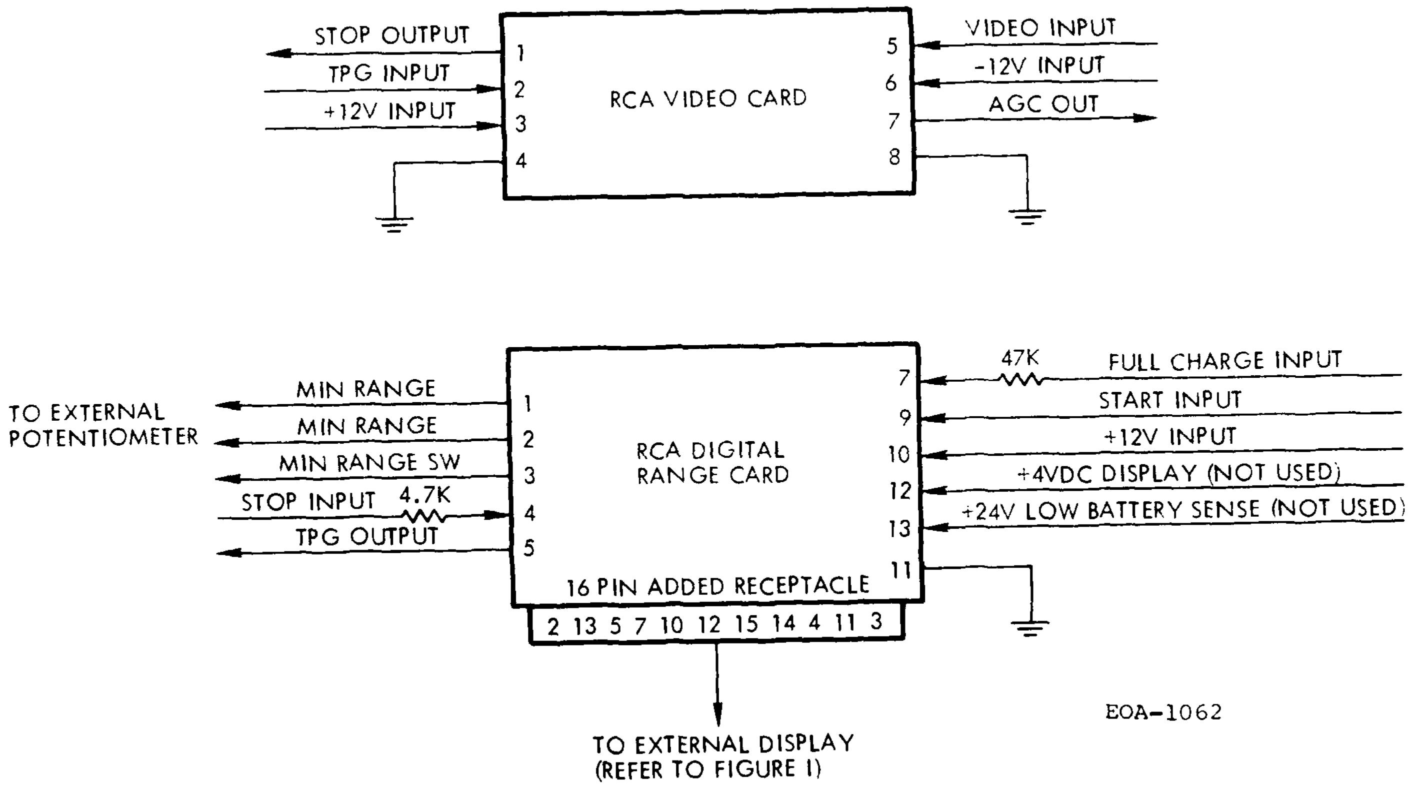


Figure 2-6. Interconnect Diagram

Pin 6 - -12 V input - power to video card from interface board (Figure 2-5).

Pin 7 - AGC output - an AGC control voltage varying from +2 to +7.5 volts to control the front end amplifier of the rangefinder and maintain a CFAR.

Pin 8 - Ground.

RCA DIGITAL RANGE CARD

Pin 1 - Min. range set } connect to front panel pot that con-
Pin 2 - Min. range set } trols minimum range setting.

Pin 3 - Min. range switch - applies +24 V when minimum range switch is activated.

Pin 4 - Stop input - stops count upon receipt of a valid pulse from RCA video card. Also, passes through the calibrate circuit.

Pin 5 - TPG output - generates proper pulse for RCA video card as described above.

Pin 6 - Not used.

Pin 7 - Full charge input - also known as pre-trigger. A positive +12 V pulse of approximately one-half second duration or less depending on the PRF.

Pin 8 - Not used.

Pin 9 - Start input - starts the range count with a pulse generated from the T_O detector as described earlier.

Pin 10 - +12 V input - power to Digital Range card from interface board (Figure 2-5).

Pin 11 - Ground.

Pin 12 - Miniature LED display +4 VDC - not used.

Pin 13 - Battery +24 V input - low battery indicator - not used.

Pins 2, 13, 5, 7, 10, 12, 15, 14, 4, 11 and 3 of 16 pin added receptacle - provides parallel drive connections for the four character selectors and the seven segment drives of the auxiliary display.

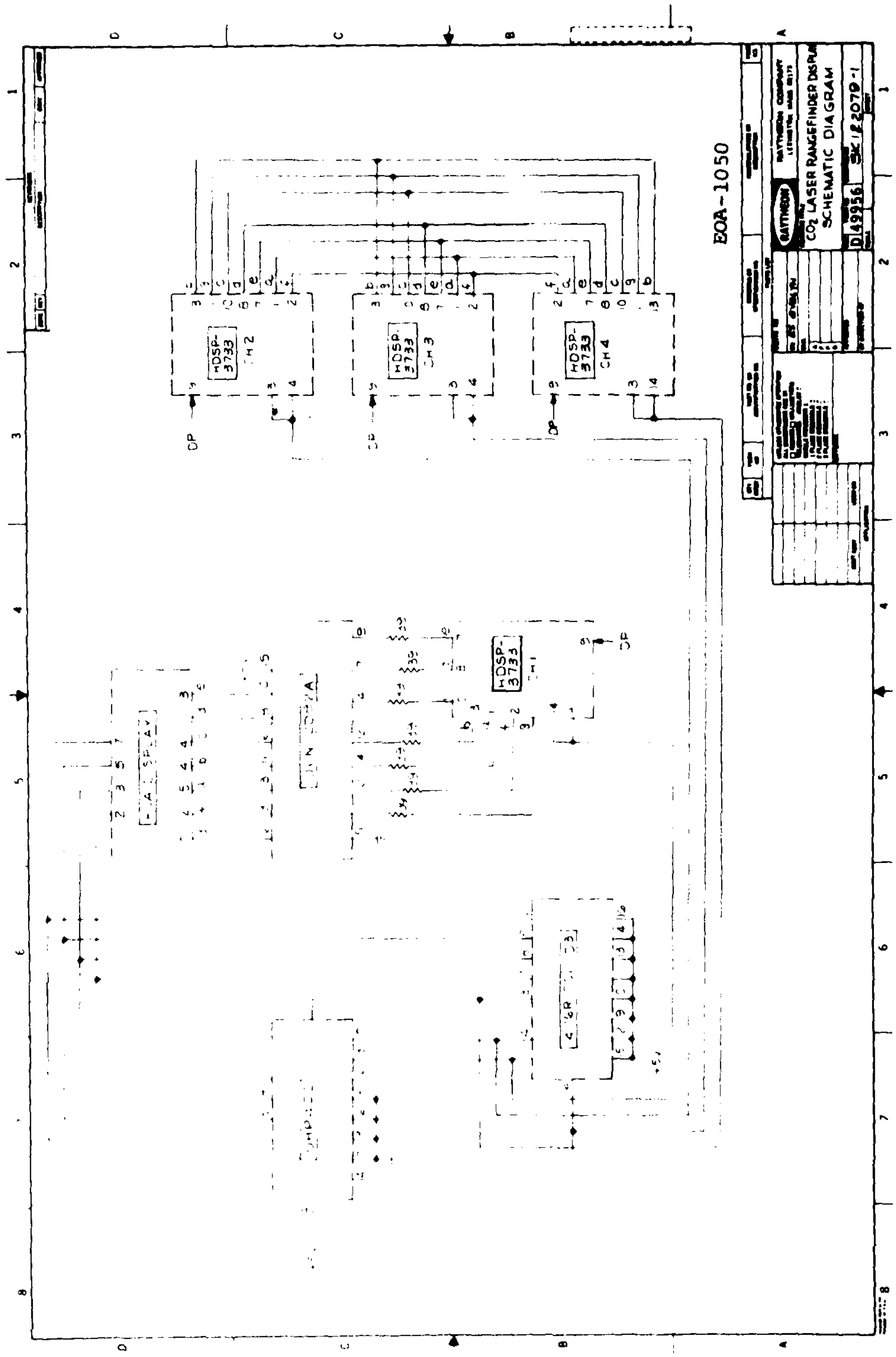
2.4.2 DISPLAY INTERFACE

The RCA Digital Range Board contains a miniature LED display, Hewlett-Packard Type 5082-7414, as an integral part of the digital read-out circuit.

In the AN/GVS-5 rangefinder, after the range count is measured in meters, it is normally presented to the small solid-state numeric indicator Type 5082-7414 referred to above and then projected optically to a larger viewing size at the operator's eyepiece. This format was not suited to our rangefinder application.

Thus, a circuit was designed to drive a larger LED four-digit display from the small Hewlett-Packard LED display on the RCA Digital Range Board. This circuit, which is shown in Figure 2-7, automatically converts the small display to a larger, easily viewed display consisting of four Hewlett-Packard LED's, Type HDSP-3733, which are located on the back of the rangefinder instrument. The operation of the circuit shown in Figure 2-7 is now described.

There are four inputs to the RCA LED display board that select one of four characters. These are on pins 6, 4, 10 and 1, respectively, of the LED display and are driven low when a character is selected. Thus, pins 6, 4, 10 and 1 were connected to a new socket (pins 7, 5, 13 and 2) and were then connected to one of the two inputs of quad two input OR gate UHP-402, while the other inputs of the OR gates were grounded. Now, when a particular character is energized, its associated OR gate inputs are both low and the OR gate open collector output goes low energizing the proper character of the larger Hewlett-Packard display at pins 3 and 14, while buffering the RCA chip. The 4116R-001-103 provides eight pull-up resistors at the RCA character drive inputs (pins 7, 5, 13 and 2) and at the open collector outputs of the UHP-402.



B-2

Figure 2-7. Display Diagram

Normally, in the AN/GVS-5, once the appropriate character has been selected, the seven segment drive lines of the RCA board energize the proper segments of the small LED with a high signal to illuminate and display the desired number. The alternate display is accomplished by bringing each of the segment input lines (namely pins 12, 11, 3, 8, 2, 9 and 7) through the new socket (pins 15, 14, 4, 11, 3, 12 and 10) to the bases of an open collector transistor array ULN-2082A. This provides proper current through emitter limiting resistors to actually drive the seven segments on display HDSP-3733. At the same time, the RCA board is properly buffered. Thus, by utilizing a parallel drive circuit to the eleven lines (four character selectors and seven segment drives) of input on the RCA board, the auxiliary display is properly illuminated as though it were located at the RCA board itself.

2.5 PRF GENERATOR/CONTROL UNIT

The PRF Generator/Control unit is contained within its own RFI shielded enclosure and is located on the lower surface of the system mounting plate. The primary system control panel for the transmitter is contained within this unit. Controls include:

- ON-OFF switch, which serves as the primary power switch for the entire rangefinder system.

- TRIGGER selector switch. When in the MANual position, the laser is fired each time the MANUAL TRIG push button is depressed. When on INTernal position, the laser fires at the rate set by the PRF switch (1 to 5 Hz rates). When on EXTernal, the laser can be fired from an external, positive going voltage (in the 1 to 6 volt range) introduced via the TRIGGER IN/OUT BNC jack. This same jack is employed when on MANUAL or INTERNAL modes as a scope-trigger source to synchronize an oscilloscope. It is NOT to be employed as a primary trigger source for the transmitter unit. The latter trigger originates at a BNC connector on the panel opposite that of the control panel.

Access to the PRF circuitry, Figure 2-8 is via an RFI gasketed access panel on the left side of the enclosure. The basic function of the PRF circuitry, Figure 2-9, is to generate the necessary conditioning pulse for the receiver (PRETRIGGER), and generate a suitably delayed laser firing pulse for the transmitter, either from its own internal, switch selectable PRF generator, or from an external source. An electro-mechanical shot counter is also incorporated within the control panel, and is driven, via a buffer stage, from the laser trigger line.

2.6 SYSTEM BLOCK DIAGRAM

The overall rangefinder block diagram is shown in Figure 2-10 wherein all subsystem interconnects are depicted within and between each major system element. Setup and operating instructions are described in Appendix A.

Overall System Specifications are as follows:

Laser	10.6 μm CO_2 TEA, Sealed
PW	80 ns spike, with minimized tail
Energy	10 mJ, TEM_{oo} mode
Beam Quality	.5 mrad divergence
Duty Cycle	1 to 5 PPS continuous, sealed
Design Life	$>10^6$ shots
Ranging	to 5 km in "clear air" @ 10 mV
Range Error	to AN/GVS-5 specifications; $\pm$10m-50m resolution
Receiver	2.7 mrad FOV; 5 in. - f/1.5 Ge aspheric
Detector	HgCdTe, with Joule-Thomson cryostat system
Electronics	Raytheon - AN/GVS-5 elements
Prime Power	24 - 32 VDC/3A

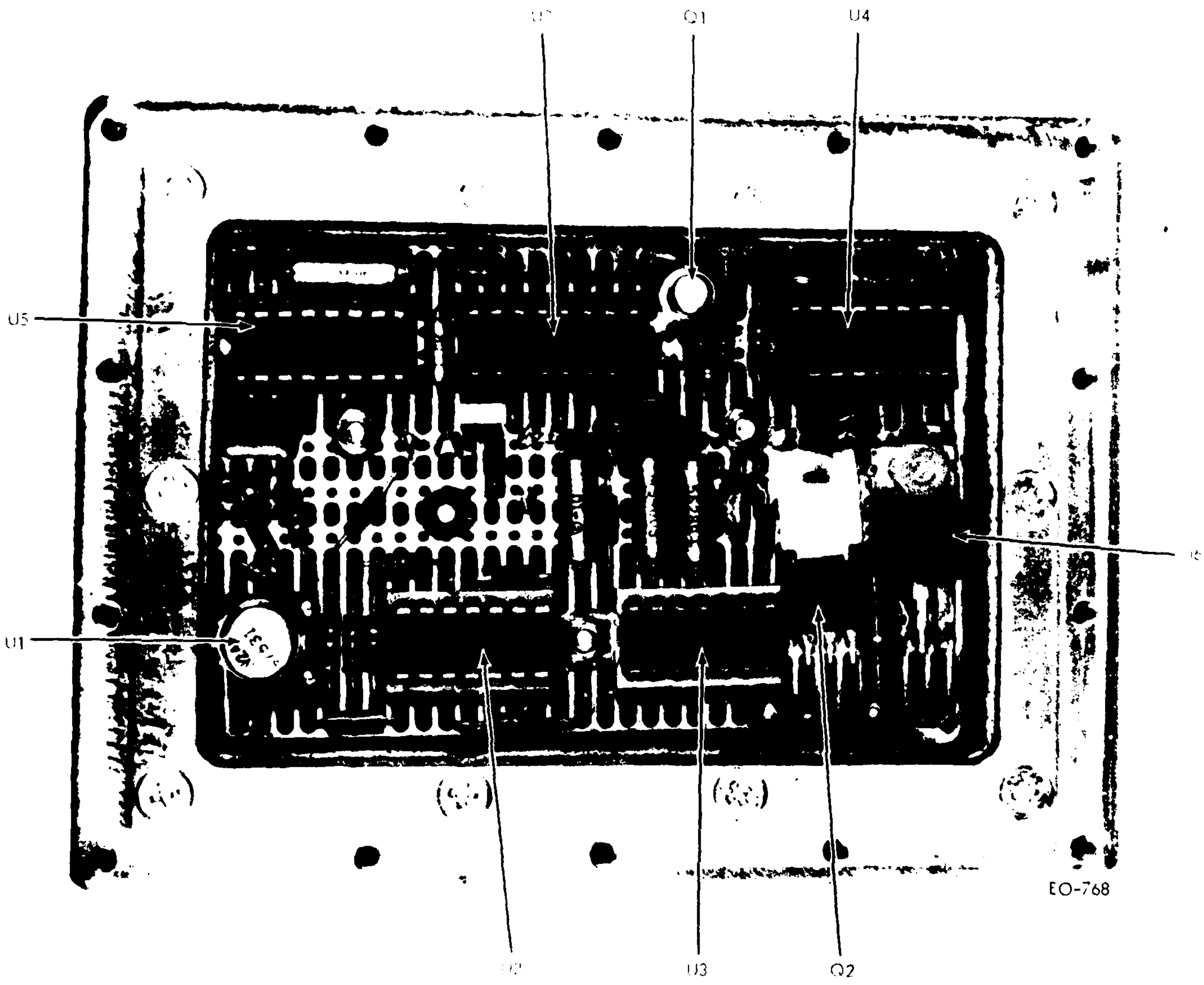


Figure 2-8. EFF Generator Circuit Components

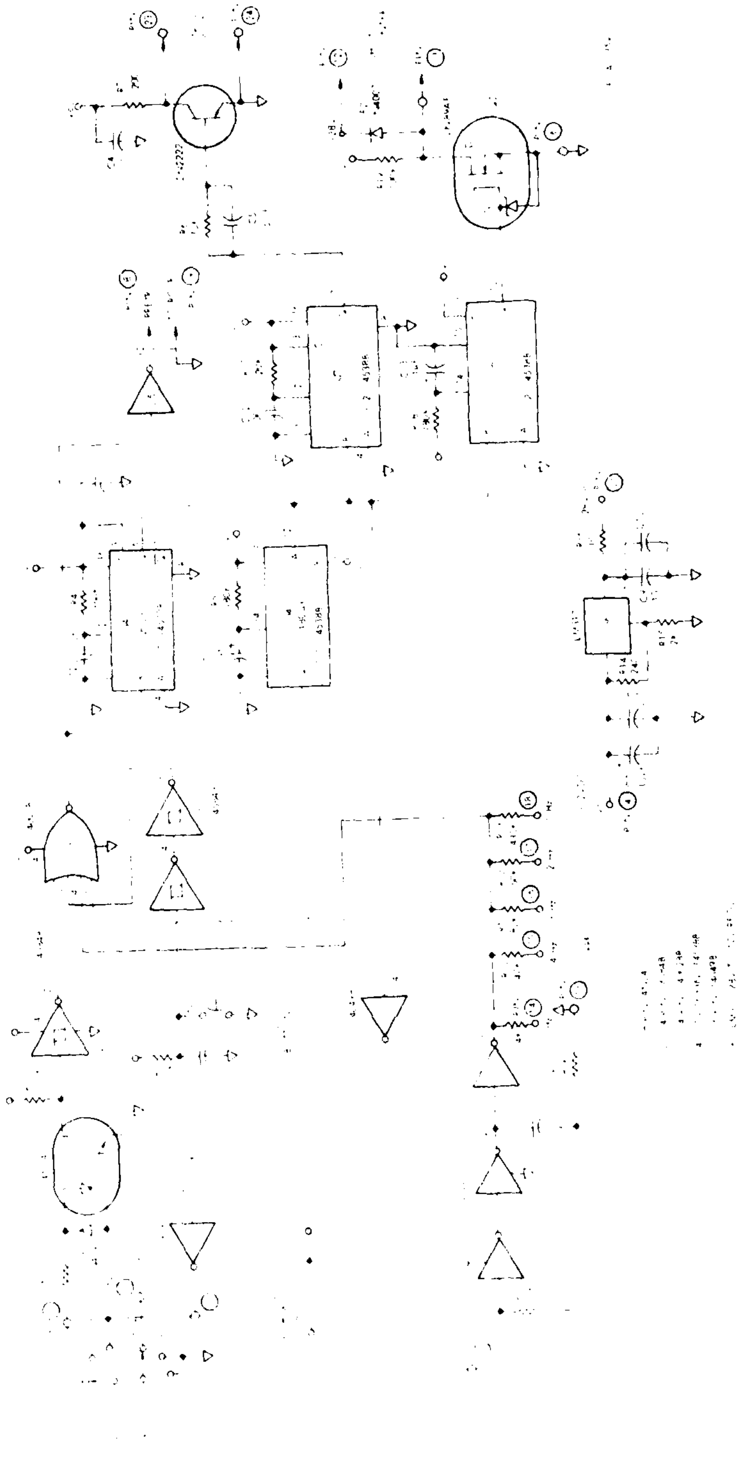


Figure 2-9. PRF Generator

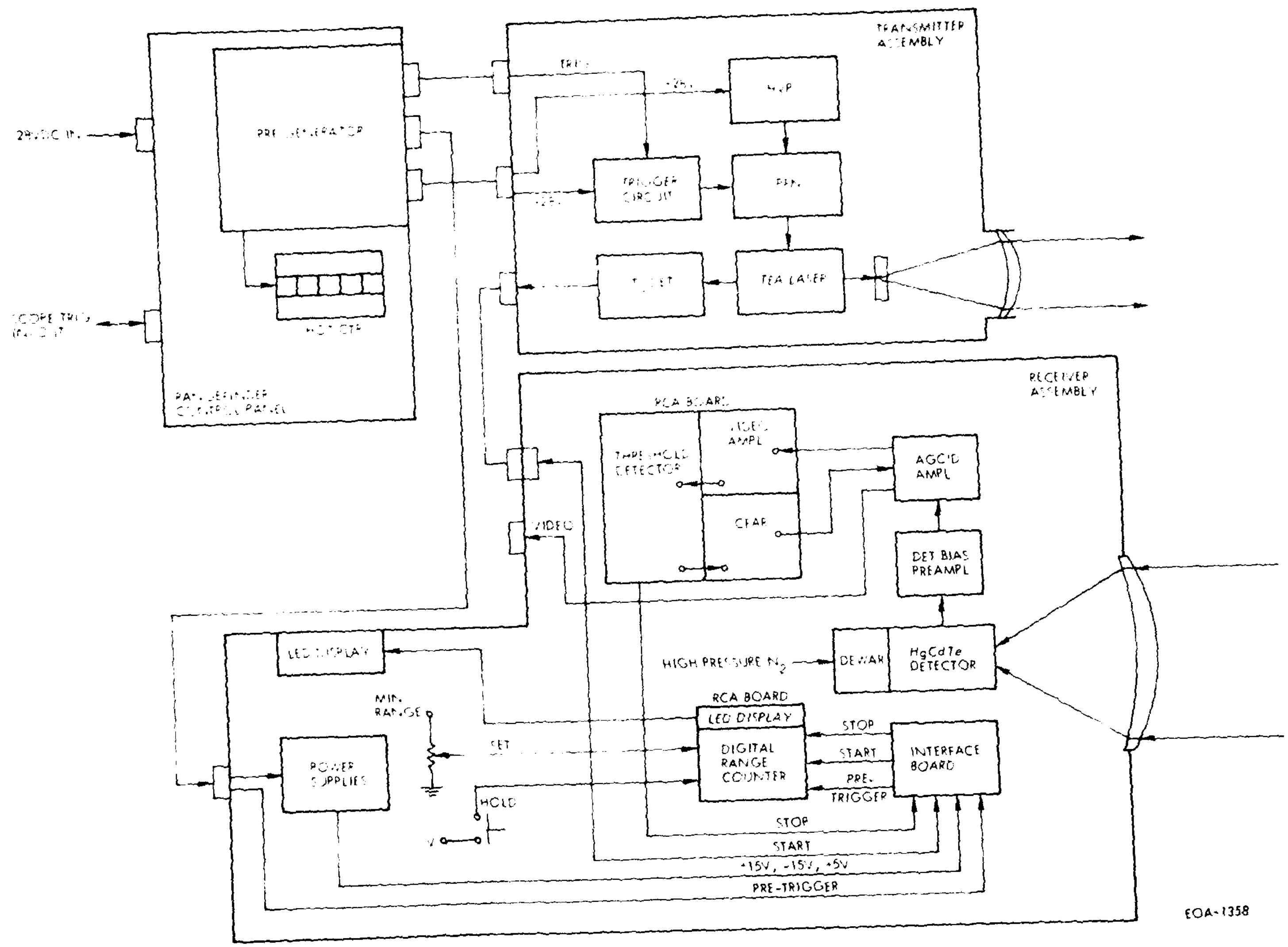


Figure 2-10. Modular Rangefinder Block Diagram

SECTION 3

SYSTEM TESTS AND CALIBRATION

3.1 CERAMIC LASER MODULE

The sealed-off ceramic TEA laser module incorporated within this system is a derivative of a design originally developed for the HSTV(L) program (HSTV-L, Contract P.O. 506320) for use in a tank environment. As such, primary design goals of inherent ruggedness, simplicity and modularity were achieved, but the laser was employed in a flowing gas arrangement for that application. Converting this basic design into a sealed-off, long life unit proved to be far more complex than originally anticipated, involving as it did, several interdependent parameters. The primary design goals were:

- Lifetime in excess of 10^6 shots
- 10 mJ output, TEM_{00} mode, pulse width of ≈75-80 ns.
- Consistent shot-to-shot performance
- Sealed-off operation @ 5 PPS

3.2 FIELD TESTS - ALIGNMENT

Since the modular rangefinder is essentially an entity unto itself, there is no external reference axis to which the system is aligned. Rather, each module (with the transmitter as prime) is internally adjusted for coincident fields-of-view. In the transmitter, the laser tube output axis, and the fixed output element of the Galilean beam expander are fixed, with the Galilean input element fully adjustable for output symmetry. In the receiver, the detector is moved laterally through the focal region of the 5.0"-f/1.5 Ge aspheric lens. Aiming is via boresighted riflescopes mounted on each unit.

3.3 TRANSMITTER ALIGNMENT

The primary frame of reference for the transmitter is the laser/PFN assembly. When these two are mated, the primary output beam axis is established and adjustments must be made within the Galilean output beam expander to match this output vector. As the main body of the beam expander (and hence, the output element as well) is keyed to the main body of the transmitter, all adjustments are made at the negative (input) element of the beam expander, where full x-y&z translational capability is provided.

Output collimation was tested by directing the beam to a distant target (a metal lightpole) approximately 6" wide and ≈1000 feet away, well into the far field of the exit system. Although the receiver had not yet been properly aligned, it was possible to detect a pulse return from the receiver of acceptable amplitude and repeatability to determine the state of beam collimation. This was achieved by slowly translating the rangefinder in azimuth, while monitoring the signal amplitude, until the signal amplitude fell to ~1/2 the original level at both edges of the beam. Estimates of the beam size proved to be quite easy to judge by noting the location of these 1/2 amplitude points in space around the target by means of the riflescope attached to the transmitter housing. Initial conditions indicated a beam diameter of 8-10 feet at the target range.

Near optimum collimation was achieved by varying the output expander's element-to-element spacing, and repeating the azimuth scan technique until the apparent spot diameter at the target pole appeared to be approximately 8-10 inches. At this point, the azimuth (but not vertical) beam position had been established, and the vertical crosshair of the riflescope set on the target.

The rangefinder was then directed to a test area, located ≈ 1500 ft. away. The 1500 ft. target area was equipped with a tripod-mounted 10.6μ CW laser, with a chopper wheel at its exit port, and a 1.0 in. dia. retroreflector, in close proximity (≈2 in.) from the chopper axis.

The receiver's 5.0 in. lens was then removed, and with the spotting scope's vertical crosshair on the retro, vertical scans were made with the rangefinder to locate the exit beam in the vertical direction. As before, it was possible to estimate beam size and location from the riflescope sight picture. Spot size was estimated at < 10 in. in 1500 ft. or a divergence of ≈.5 mrad. The horizontal crosshair in the riflescope was then centered on the retroreflector, and the rangefinder locked down, its output axis having been exactly defined.

3.4 RECEIVER ALIGNMENT

With the transmitter axis aligned and coincident with the retro/chopped CW source at 1500 ft., the transmitter was turned OFF, and the receiver lens installed in the receiver box. Optimum detector focus is achieved by screwing the lens in and out of the receiver housing. X&Y adjustment capability exists in the detector/Dewar mounting flange. Optimum detection of the chopped 10.6 μ source was achieved by maximizing the signal return by appropriate x-y-z adjustments in the receiver. Optimum focus was checked by a slow azimuth scan of the rangefinder about the chopped CW beam axis. Signal level remained essentially constant ≈ ±2 ft. around the signal source, which agrees well with the receiver's FOV, and indicates that the detector was at the prime focus of the lens.

3.5 TEST RESULTS

Final tests were conducted from the Sudbury E-O test site, whose maximum range capability (terrain limited) is ≈2900 meters, S/N readings of ≈30 dB were achieved from three separate targets aroung 2800 meters. Shot-to-shot repeatability was excellent, with only minimal signal amplitude fluctuations, presumed to be due primarily to scintillation effects.

Multiple target discrimination was also demonstrated by setting the minimum range pot to a range slightly greater than the nearest target, and range readings were made to the furthest target. Figures 3-1 and 3-2 show typical signal returns, a forest service lookout tower @ 2700 meters.

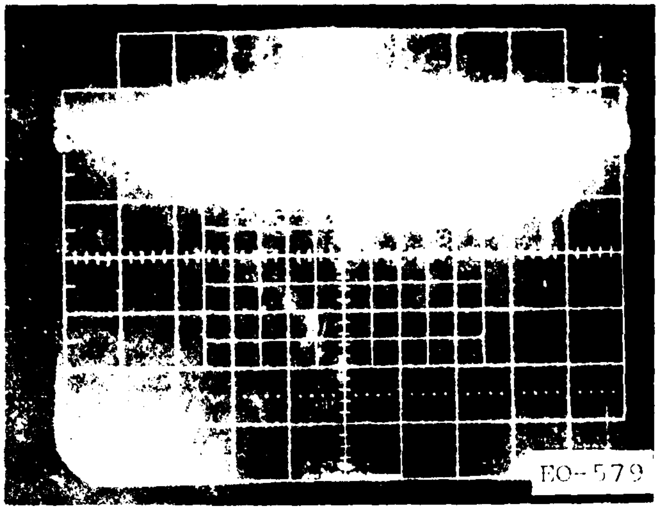


Figure 3-1. Lookout Tower Signal @ 2700M
Vert = 10 mV/Div - Horiz = 2 μs/Div

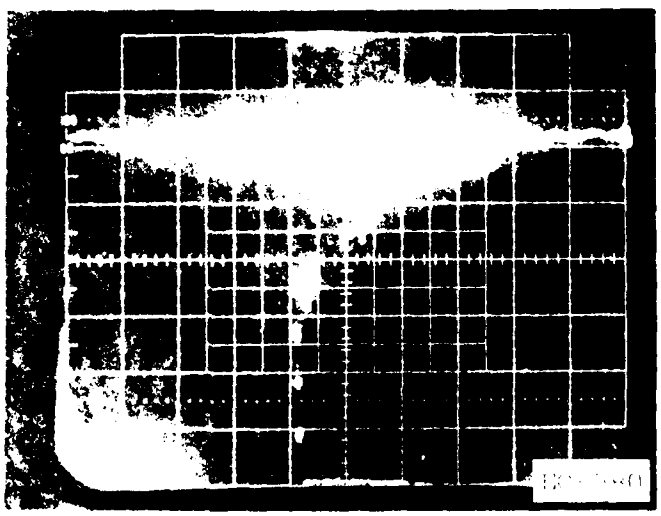


Figure 3-2. Lookout Tower Signal @ 2700 Meters - Expanded Scale
Vert = 10 mV/Div - Horiz = 200 ns/Div

In June of 1980, the unit was returned for refurbishment following a series of tests at Fort Belvoir, VA. A summary of the refurbishment effort and additional tests is summarized in Raytheon memo AAC-80-08, dated 8 August 1980, submitted under separate cover as Appendix B.

APPENDIX A

RAYTHEON CO_2 LASER RANGEFINDER SETUP AND OPERATING INSTRUCTIONS

The Rangefinder consists of three primary subsystems, all of which are mounted to a common plate. The plate, in turn, is intended for tripod mounting, via a pattern of tapped 1/4-20 holes in its center. Boresight reference lugs are incorporated on the upper plate surface for the transmitter and receiver units, and interface with the lugs via "keyholes" in the subsystem base plates.

PRF Generator/System Control Box

This unit is mounted on the lower surface of the mounting plate and serves as the primary control panel for the rangefinder, and as a power distribution panel for the transmitter and receiver units. The control panel contains the following controls/connectors.

On-Off Power Switch - Turns on internal electronics associated with the PRF generator. Supplies 28VDC to laser HVPS, and to the receiver unit.

Trigger Selector Switch - Selects three modes of operation for the unit. In MANual mode, the laser is fired via the MANUAL TRIG. push button on the panel. In INTernal mode, the laser fires automatically at the rate set (1-2-3-4-5- Hz) by the PRF switch. In EXTernal mode, the laser can be fired remotely by connecting an external trigger (+5 to 10 volts) to the front panel BNC connector. The pulse width should be at least 20 μsec, and the PRF of the external source should not exceed 5/sec.

Trigger In/Out Connector (BNC) - This input/output connector serves a dual purpose. In EXTernal mode, accepts external command pulses, as described above. When on INTernal or MANual modes, supplies a ≈40 μsec/5V sync pulse coincident with the pre-trigger pulse for scope triggering, primarily for diagnostic purposes.

UNDER NO CIRCUMSTANCE SHOULD THIS OUTPUT BE USED TO TRIGGER THE LASER TRANSMITTER.

+28 VDC Connector - Prime power connector, from 24/28 VDC-3A external power source.

RCVR Connector - Supplies 28 VDC power and pre-trigger pulse to the receiver unit.

"T_o" Connector - Not Used - Covered with red plastic cap.

Rear Panel Connectors:

"+28 DC" Connector - Supplies 28 VDC to the transmitter unit. It must be emphasized that the laser's PFN is fully charged to 12,000 volts whenever the control panel is switched ON. Extreme care must be taken if the transmitter unit is operated without its top cover.

Laser Trigger (BNC) - Supplies trigger to the laser PFN assembly within the transmitter unit.

TRANSMITTER ASSEMBLY

This unit contains the ceramic TEA laser PFN, high voltage power supplies, trigger circuit and a pyroelectric detector/amplifier used to generate a start pulse (To). The unit also incorporates a two-element, removable beam expander of the Galilean type, with an overall expansion ratio of ≈11.3X. The transmitter unit can be removed from the mounting plate by rotating the tab at the rear of the unit, pulling the unit rearward to the stops, and lifting it out via the round portion of its "keyhole" slots. A variable power sighting scope is situated along the upper left edge of the transmitter, and is boresighted to the laser's output beam axis. The transmitter has no controls directly incorporated within itself, being controlled entirely from the PRF generator unit. Connectors on its rear panel are:

TRIGGER (BNC) - Accepts the trigger pulse from the rear panel jack of the PRF Generator.

"+28VDC" - Connected to the six pin connector at the rear panel of the PFN generator.

"T_o" Connector (SMA) - Laser fire (start) pulse output to the receiver unit.

RECEIVER ASSEMBLY

The receiver assembly contains all of those elements associated with signal detection and calculation of range. The 5" diameter, f/1.5 receiver lens focuses its signal energy on the surface of a Joule-Thomson cooled HgCdTe, .020 in. detector, whose effective FOV is 2.7 mrad (see Figure A-1).

Post detection electronics are a combination of Raytheon and AN/GVS-5 circuits, contained in RFI shielded compartments on two sides of the unit, and are accessible via removable panels.

The rear section of the enclosure contains the LED display system, low voltage power supplies and controls associated with the AN/GVS-5 range gate circuit.

A high pressure gas fitting is located on the right side panel for mating with an external source of high pressure/high purity nitrogen for the J-T system. Control panel controls/connectors are as follows:

ON-POWER SWITCH - Turns receiver electronics on. However, it works only in conjunction with the PRF generator On-Off switch, i.e., receiver cannot be turned on unless the PRF generator On-Off switch is also on.

MINIMUM RANGE SET/HOLD - Sets the rangefinder minimum range by pressing the hold switch, and turning the set knob to whatever minimum range is desired. This range is displayed on the LED readout as long as the button is depressed.

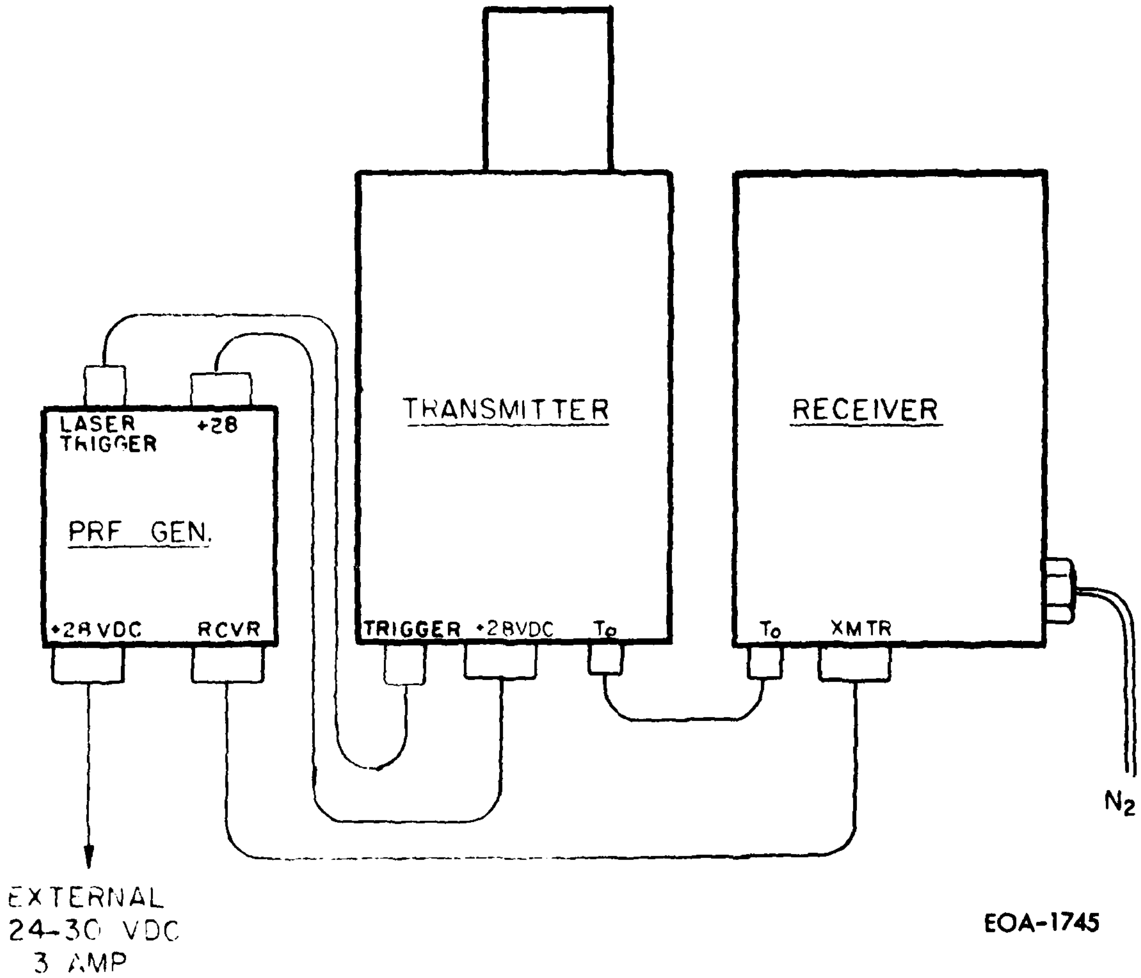


Figure A-1. Interconnecting Diagram

VIDEO (BNC) - Used to view the detected and amplified signal at the output of the Raytheon post-detection amplifiers.

"XMTR" CONNECTOR - The connector on which 28 volt power and the system's pre-trigger pulse are supplied from the PRF generator unit.

T_o CONNECTOR (SMA) - The connector on which the start pulse (T_o) is introduced from the transmitter unit.

HIGH PRESSURE N_2 FITTING - Should be connected to a supply of ultra pure grade (99.999%, -105^{o}F dew point) nitrogen, preferably via a high pressure line incorporating a line filter (SBRC Mod 5684 or equiv.). Input pressure should be in the range 1800 psi to 3000 psi.

DAT
FILM